Chapter 1: Introduction to the Cleaner Technologies Substitutes Assessment

1.1 BACKGROUND AND METHODOLOGY

Flexography is a process used primarily for printing on paper, corrugated paperboard, and flexible plastic materials. Flexography uses a soft, flexible printing plate that is mounted on a rotary cylinder. Flexographic presses are equipped with anywhere from one to as many as twelve color stations. Examples of items printed with flexography include comics, newspapers, appliance boxes, and many grocery store packages – including cereal boxes, shampoo and soda bottle labels, frozen food and bread bags, and milk cartons.

Flexography accounts for about 20 percent of U.S. printing industry output, and it is the world's fastest growing printing technology. The nearly 1,000 U.S. flexography companies employ 30,000 people, have annual sales of $4.7 billion, and use more than 475 million pounds of ink per year. Over 60% of flexography companies have fewer than 20 employees.

The Design for the Environment (DfE) Program comprises several voluntary partnership-based initiatives between the U.S. Environmental Protection Agency (EPA) and various industries. DfE works directly with companies to integrate health and environmental considerations into business decisions. DfE serves as a catalyst for lasting change that balances business practicalities with sound environmental decision-making. The DfE approach is intended to compare performance, risks, and costs associated with alternatives to traditional industrial systems, materials, and methods. A primary goal of DfE is to encourage pollution prevention rather than relying on end-of-pipe controls to reduce risks to human health and the environment.

In accordance with its mission, DfE's intention was to ensure that all work on the Flexography Project, including technical research, analysis, and outreach, would be performed collaboratively. Toward this end, DfE first formed a Steering Committee consisting of representatives of several flexographic trade associations. The Steering Committee provided leadership, technical expertise, and guidance, meeting about once a month throughout the Project. In addition, the Project set up a Technical Committee, which included representatives of flexographic trade associations, ink formulators, printers, suppliers to the printing industry, academic institutions, and EPA. The trade associations alone that participated in the Project represent over 1,600 flexographic printers and ink manufacturers. (The members of the Steering and Technical Committees are listed in the front of this book.) Also, to ensure substantial read-world technical expertise, other participants were brought into the Project, including the printing program at Western Michigan University, the University of Tennessee's Center for Clean Products and Clean Technologies, the Industrial Technology Institute, and a number of technical experts at the U.S. Environmental Protection Agency.

The Project Partners understood that many small fleography companies rarely have the time or resources to gather in-depth information on safer and lower-risk alternatives to current materials and processes. Therefore, they set a goal of providing information that could help flexographers make their businesses more environmentally sound, safer for workers and the public, and more cost-effective.

The Partners decided to make the Project a comparative assessment of flexographic inks, since inks constitute a major cost category and have a variety of environmental and health issues. Factors that were considered in selecting this research topic included awareness of health issues related to chemicals used in traditional solvent-based inks, growth of the flexographic industry, significant recent advances in flexographic technology, and increasing attention to regulations. They decided to particularly study printing of inks on film substrates because there was less documentation about some ink systems on these substrates and because this area presented technical and environmental challenges, including air regulations related to pollutant emissions, worker health and safety issues, and some hazardous waste concerns. The Partners decided to run the inks on wide-web presses because of the technical challenges facing flexographic printers in using water-based and UV-cured inks to print film substrates on these presses.

The Partnership analyzed three ink systems: solvent-based, water-based, and ultraviolet-cured, the last of which is a fairly new technology. Solvent-based inks represented the industry benchmark for ease of use and quality of results. The inks traditionally used in this system, however, contain solvents made of volatile organic compounds and other chemicals, which can pose risks to human health and the environment. (See Chapter 2 for an overview of the ink systems that were analyzed.)

The research compared more than 100 flexographic ink chemicals, based upon actual printing of the inks on three substrates. The research examined the tradeoffs associated with traditional and alternative flexographic ink chemicals. These tradeoffs include environmental concerns (such as risk, environmental releases, energy impacts, and resource conservation), performance, and cost. Many of these issues are frequently overlooked by conventional analyses. The industry Partners in the Project felt that a combination of production results from actual printing facilities in addition to laboratory research would help give printers a more comprehensive perspective. As with any “real-world” research, the Partners were confronted with situations that they could not have anticipated. Occasionally this required modifications of the methodology specifications. (Such situations are noted in relevant sections of the document.) Therefore, the results of the research are both more extensive and less comparative than they might have been if a smaller set of variables had been chosen.

The Partners developed a detailed methodology for testing the ink systems, which involved (1) performance demonstrations at eleven volunteer printing facilities and (2) laboratory runs conducted at the printing facility of Western Michigan University (WMU). The methodology included the following general steps:

The performance demonstration printing sites supplied detailed information about their facilities and the press used in the flexographic demonstration.

- Each printing site ran a demonstration.
- Western Michigan University conducted technical analyses of the printed samples, and provided them to the Partners.

- The University of Tennessee used facility information to analyze energy consumption and costs.
- The EPA Risk Workgroup used a variety of types of existing information to analyze the hazards and risks of the ink chemicals and ink systems.

The methodology is described in more detail in the relevant sections of this document. For example, the methodology for the performance demonstrations and laboratory runs can be found in Chapter 4 (Performance) and its appendices.

1.2 WHAT RESULTS DID THE PROJECT GENERATE?

Finally, all the information about methodology and findings was combined into this document, which is called a Cleaner Technologies Substitutes Assessment, or CTSA The foundation for this CTSA was the careful consideration of all facets that affect flexographic inks, including aspects that many firms fail to address at all. The goal of this project is to help industry include these aspects in business decisions, and thereby to improve both private business and the larger environment. Although this CTSA focuses on flexographic inks, the *approach* that was used is transferable to other business decisions.

In addition to the CTSA, the Project has developed a number of other documents and tools to help printers, ink formulators, technical assistance providers, and others interested in the findings. Case studies, a summary booklet of the CTSA results, a fact sheet that describes the Flexography Project's goals and products, and many other materials can be obtained from the DfE website (www.epa.gov/dfe).

1.3 WHO WILL BENEFIT FROM THIS RESEARCH?

The CTSA documents what is arguably the most detailed analysis ever performed on flexographic ink chemicals. Small printers, ink formulators, technical assistance providers to the printing industry, and others interested in technical information about flexography, printing inks, or environmentally focused information about the printing industry may all find this information useful.

The CTSA provides data to help **ink formulators** develop high-quality inks using fewer chemicals that pose risks to human health and the environment. **Printers** can identify formulations and ink systems that may print equally well for specific purposes while posing fewer safety, health, or environmental concerns as well as possibly easing regulatory compliance. **Technical assistance providers** can find a wealth of information in the CTSA to help small businesses think through the many issues in selecting an appropriate ink system that incorporates health and environmental considerations as well as performance and cost information.

The benefits of the CTSA include its wealth of detailed information about a large group of chemicals (more than 100), including many common chemical categories found in flexographic inks. In addition to the original performance demonstration study, a huge amount of work was done to bring all the existing information together in a way that would be helpful to flexographic professionals. The hundreds of tables and charts provide detailed data about hazards, risks, environmental releases, and other aspects of ink chemicals that can be difficult to locate but are very important to consider when choosing or evaluating ink technologies and systems.

The CTSA, despite its detail, represents only a "snapshot" taken of a specific printing sample demonstrated by a small, non-random number of performance sites at a specific time. In addition, the inks used in the performance demonstrations were selected and donated by ink manufacturers, and only three types of film were used as test substrates. Therefore, readers should not assume that the information in the CTSA represents the most comprehensive or current information about flexographic printers, inks in general, or results on other substrates. On the other hand, although many of the findings are specific to the flexographic sector, the systematic process of investigation and much of the data about chemicals will be valuable to many other printing professionals.

1.4 OVERVIEW OF THE CTSA

This CTSA consists of two volumes. Volume I contains the text, and Volume II includes Appendices that provide important background information about the CTSA. Because the CTSA contains so much information, it may be helpful to use specific sections to suit different needs.

The list that follows may help readers locate particular types of information quickly.

Table of Contents: The Contents at the front of Volume 1 contains a detailed breakdown of the topics discussed in every chapter. A scan of the Contents can provide a good orientation to the material contained in this document.

Results and Implications of the Research: Readers who want a quick overview of the most important findings of the research should begin by reading the **Executive Summary**, which precedes Chapter 1 of the CTSA. **Chapter 8 (Choosing Among Ink Technologies)** contains a more detailed discussion of the interactions between risk, performance, and cost, and provides comparative interpretations of the results by ink system and chemical category. This chapter will be most helpful to professionals who are interested in considering alternatives to current inks and in developing cleaner products.

Chapter Overview: A table of contents and overview are provided in a box at the beginning of each chapter to help readers quickly identify and locate relevant information.

Background: The **Glossary** at the front of Volume 1 defines a number of technical terms that are used in the document. A list of **Abbreviations** that are mentioned frequently in the text follows the Glossary. **Chapter 2 (Overview of Flexographic Printing)** provides general information about the flexographic industry, the components and safety aspects of the ink systems that were studied, and federal regulations relevant to flexographic printing.

Performance Information: The research examined 45 ink formulations. A total of 18 performance tests were chosen and run, combining performance demonstrations at volunteer printing facilities and laboratory runs and analysis. **Chapter 4 (Performance)** describes the results of the tests. The chapter first discusses the performance of solvent-based and water-based inks, then ultraviolet-cured (UV) inks, and finally profiles each facility where performance demonstrations were conducted.

Environmental Information: **Chapter 3 (Risk)** discusses the environmental issues, including hazards to aquatic life, exposure of printing industry employees and the general public, and risk concerns that were identified in the research. Information about natural resource consumption related to this study is discussed in **Chapter 6 (Resource and Energy Consumption),** and pollution prevention and control options are mentioned in **Chapter 7 (Additional Improvement Opportunities). Chapter 2 (Overview of Flexographic Printing)** discussed federal environmental regulations that are relevant to the flexographic printing industry.

Cost Information: Different aspects of cost are discussed in **Chapter 5 (Cost),** as well as in **Chapter 8 (Choosing Among Ink Technologies).**

Supplementary Information: **References** cited in the text are numbered and listed at the end of each chapter. The **Appendices**, which are provided in **Volume 2,** contain a great quantity of background information and research data to supplement the main text. Each appendix is numbered to match the chapter to which it relates; for instance, Appendix 3-A contains details about the information in Chapter 3.